CONFERENCE ON DISARMAMENT

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PROGRESS REPORT TO THE CONFERENCE ON DISARMAMENT ON THE FORTY-FOURTH SESSION OF THE AD HOC GROUP OF SCIENTIFIC EXPERTS TO CONSIDER INTERNATIONAL COOPERATIVE MEASURES TO DETECT AND IDENTIFY SEISMIC EVENTS

1. The Ad Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events (GSE), initially established in pursuance of the decision taken by the Conference of the Committee on Disarmament on 22 July 1976, held its forty-fourth formal session from 20 through 24 May, 1996, in the Palais des Nations, Geneva, under the Chairmanship of Dr. Ola Dahlman of Sweden. This was the thirty-sixth session of the Group, convened under its new mandate by the decision of the Committee on Disarmament at its 4th meeting on 7 August 1979.

2. The Ad Hoc Group is open to all Member States of the Conference on Disarmament. It is also open on a standing basis to all non-Member States which have been invited upon their request by the Conference on Disarmament to participate in its work. Accordingly, scientific experts and representatives of the following Member States of the Conference on Disarmament participated in the session: Argentina, Australia, Belgium, Brazil, Bulgaria, Canada, China, France, Germany, Hungary, Italy, Japan, Mongolia, Netherlands, Pakistan, the Russian Federation, Sweden, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

3. Scientific experts and representatives from the following non-Member States of the Conference on Disarmament participated in the session: the Czech Republic, Denmark, Finland, Israel, Kazakstan, Norway, the Republic of Korea, the Republic of South Africa, Spain, Switzerland, Turkey and Ukraine.

4. During the session 39 papers containing information on national investigations related to the work of the Group were presented by participating experts and reviewed by the Group. In addition, substantial technical and scientific material was presented by the three GSETT-3 Working Groups on Planning, Operations and Evaluation.

5. The Ad Hoc Group reviewed results from its Third Technical Test, GSETT-3, and noted that this test is now well into its second year of successful full-scale operation. The Working Group on Operations reported that there are now 43 primary stations and 87 auxiliary stations contributing data to the GSETT-3 IDC. A number of additional auxiliary stations have contributed data but have been temporarily removed from the network because of low reliability. Botswana and the Republic of Korea have recently announced their intention to provide data from primary stations. Data from the Korean station is already being transmitted to the GSETT-3 IDC, and data from the station in Botswana will be available at the GSETT-3 IDC in the near future. Bulgaria, China and Hungary have begun contributing supplementary data, bringing the total number of countries contributing such data to 23. The GSETT-3 network currently in operation is shown in Annex 1.

The GSE Chairman, assisted by the GSE Secretary and the Convenor of the Working Group on Planning, as well as several individual delegations, have worked actively with countries to increase participation in the network envisaged for the IMS.

6. The GSETT-3 IDC has continued its successful operation, with gradual improvements of the procedures. In particular, the new Detection and Feature Extraction and the Global Association software packages have resulted in marked improvements on the data processing. The number of unassociated detections has decreased significantly for both the primary stations and for the auxiliary stations. Furthermore, the number of phases in the Reviewed Event Bulletins which have had to be retimed by analysts, has also decreased significantly.

7. After presenting a comprehensive evaluation report on the first year of GSETT-3 in February, the Working Group on Evaluation (WGE) has continued an ongoing evaluation of GSETT-3, focusing on specific aspects of the experiment. In particular, the WGE has evaluated the effects of the new detection and event definition software described above. Even though these procedures have been in effect for only a short time, the WGE concludes that they have been proven to have significantly increased the quality of the final GSETT-3 products.

The WGE has also performed an in-depth investigation of the auxiliary data retrieval mechanism, and this study has led to several concrete suggestions which could improve the performance of this mechanism. In addition, other issues such as magnitudes, source characterization parameters and the GSETT-3 documentation have been reviewed.

8. In planning its future work, the Group will be guided with respect to GSETT-3 by the provisions contained in CD/1385, paragraph 20. Therefore, to provide assistance for implementation of the CTBT, the Group should complete a comprehensive report on GSETT-3 by August 1996 for the Conference on Disarmament. The report should contain, inter alia, the results and current conclusions of GSETT-3 and could be available to the envisaged Preparatory Commission. Following the completion of that report, the Group recommends the continuation of the work begun under GSETT-3 until the Preparatory Commission assumes responsibility, including financing, for the work on establishing the International Monitoring System. This would allow the uninterrupted operation and development of the evolving IMS, including the prototype IDC, as well as continued calibration of the IMS.

9. The GSE recommends that delegations participating in GSETT-3 plan and schedule the transition to those facilities proposed for inclusion in the IMS so that practical experience can be obtained.

10. At its proposed August 1996 meeting the GSE should:

- complete a comprehensive report on GSETT-3;
- complete the calibration plan, an initial version of which is contained in Annex 2;
- perform a thorough review of technical standards for the eventual IMS stations. The preliminary specifications given in CD/1211 should be revised in light of the GSETT-3 experience.
- continue to solicit increased participation by stations envisaged for the IMS.

11. The Group noted that its recent evaluation of the first full year of GSETT-3 (CD/1385 and GSE/43/CRP.262) identified several specific areas in which additional work is needed by the prototype IDC, including

- enhance the documentation of GSETT-3 procedures and of the hardware and software systems which will be needed for the IMS;
- increase the effectiveness of the automated procedures;

-- implement additional features such as associated waveforms for specific events in the Automatic Data Request Manager (AutoDRM) and subscription mechanisms;

-- improve procedures for the use of data from Auxiliary Seismic Stations to make data requests more effective;

-- continue the fine tuning and improvements of all stages of automatic processing;

-- continue integrating data from other technologies on a step-by-step basis into the prototype IDC's processing system. The resulting analyses should be reflected in the IDC bulletins so that this information, together with the raw data, will be available to experts from all IMS technologies;

-- continue the calibration of the system.

The Group also noted the need for additional work by NDC's, particularly in the following areas of study:

-- comparison of signal detection algorithms at the NDC's and the prototype IDC

-- comparison of supplementary data and IDC locations for specific regions

-- provision of data useful in various aspects of seismological evaluation

-- monitoring of station performance and reporting to the prototype IDC.

12. The GSE recommends that an external audit of the prototype IDC system be undertaken to obtain an independent assessment of the status of both hardware and software with emphasis on the documentation, in order to assure the operability and maintainability of the prototype IDC system to be transferred to the future CTBT Organization.

13. The Ad Hoc Group noted with appreciation the convening of an informal regional workshop in Pretoria, South Africa for the African region from 22 to 24 April 1996 in which 35 diplomats and scientific experts from 21 countries participated. This workshop followed a similar workshop, previously reported, for the Central and South America region in San Juan, Argentina in November, 1995. The purpose of these workshops was to increase awareness of the GSETT-3 experiment and the future International Monitoring System of the CTBT, and to encourage the participation of countries in these regions. The workshops were well attended by seismologists and government representatives from many countries in the respective regions. A summary of the results of these workshops is presented in Annex 3. A third regional workshop focusing on participation in the future IMS of the CTBT is being planned for the South East Asian region in September 1996.

14. In the context of these regional workshops, the Ad Hoc Group noted that training and education of experts worldwide will be an important issue in the future monitoring system. The IMS will need trained experts in all the monitoring technologies, both at the national level and at the IDC. The Ad Hoc Group noted with appreciation that several initiatives have already been taken in this regard, both by national delegations and by the GSETT-3 IDC, and encourages additional such initiatives in the future.

15. The Ad Hoc Group noted with appreciation the convening of an informal International Conference: "Technologies to Monitor CTBT. The Role and the Place of National Data Centres in the International Monitoring System" in Moscow, Russia, from 13 to 19 May 1996. The

Conference was attended by 137 technical experts from 12 countries. The objective of the Conference was to stimulate discussion on technical aspects of NDC operation, such as equipment, algorithms and software issues, as well as communication means and data transmission. The Conference provided a good opportunity for experts from different countries to discuss problems of nuclear test ban monitoring, and is expected to further contribute to the process of establishing a CTBT International Monitoring System.

16. The Ad Hoc Group suggests that its next session, subject to approval by the Conference on Disarmament, should be convened from 5-16 August 1996.

ANNEX 1

Table 1: Status of GSETT-3 Station and Gamma Data Commitments as of 24 May 1996

Country	GSETT-3 Primary Stations Envisaged by GSE	GSETT-3 Auxiliary Stations Offered	Station Commitment Status	Data Available to IDC	Gamma Data Committed/ Provided to IDC
Argentina	1	2	committed	1994/1996/7	yes/no
Armenia	0	1	committed	1996	-
Australia	5	12	committed	1994	yes/yes
Austria	0	1	lacking	unknown	-
Belgium	0	0	not applicable	not applicable	yes/no
Bolivia	1	-	committed	1995	-
Botswana	1	-	committed	1996	-
Brazil	1	2	committed	1994/1996	yes/no
Bulgaria	0	1	committed	1996	yes/yes
Canada	6	18	committed	1994	yes/yes
Cen. Afr. Republic	1	-	committed	1994	-
Chile	0	1	committed	1995	yes/no
China	3	0	committed	1995/1996	yes/yes
Colombia	1	0	committed	1996	yes/no
Cook Islands	0	1	committed	1994	-
Costa Rica	0	1	committed	1995	yes/no
Czech Republic	0	1	committed	1994	yes/no
Denmark	0	1	committed	1996	yes/yes
Egypt	1	0	lacking	unknown	-
Ethiopia	0	1	committed	1995	-
Fiji	0	1	committed	1996	-
Finland	1	2	committed	1994	yes/yes
France	1	0	committed	1995	yes/yes
Germany	1	9	committed	1994	yes/yes
Hungary	0	1	committed	1994	yes/yes
Iceland	0	1	committed	1995	-
India	1	0	committed	unknown	-
Indonesia	1	-	lacking	unknown	-
Iran, Islamic Rep. of	1	2	committed	1996	yes/no
Israel	0	4	committed	1995/1996	yes/yes
Italy	0	2	committed	1994	yes/yes
Ivory Coast	1	-	committed	1995	-
Japan	1	7	committed	1994/1996	yes/yes
Kazakhstan	1	3	committed	1996	-
Kenya	1	-	lacking	unknown	-
Republic of Korea	1	-	committed	1996	-
Mexico	1	2	lacking	unknown	-
Mongolia	1	1	committed	1995/1996	-
Namibia	0	1	committed	1995	
Netherlands	0	1	committed	1994	yes/no
New Zealand	0	1	committed	1994	yes/yes

Country	GSETT-3 Primary Stations Envisaged by GSE	GSETT-3 Auxiliary Stations Offered	Station Commitment Status	Data Available to IDC	Gamma Data Committed/ Provided to IDC
Norway	3	1	committed	1994/1996	yes/yes
Pakistan	1	1	committed	1995/1996	-
Papua New Guinea	1	-	committed[1]	1995	-
Paraguay	1	-	committed	1994	-
Peru	0	1	committed	1996	yes/no
Philippines	0	1	committed	1995	-
Poland	0	1	committed	1996	yes/yes
Portugal	0	1	committed	-	-
Romania	0	1	committed	1996	yes/yes
Russian Federation	5	5	committed	1994/1996	yes/yes
Seychelles	0	1	committed	1995	-
Solomon Islands	0	1	committed	1995	-
South Africa	1	2	committed	1994/1996	yes/yes
Spain	1	2	committed	1995	yes/yes
Sweden	1	0	committed	1995	yes/yes
Switzerland	0	2	committed	1995/1996	yes/yes
Thailand	1	-	committed	1995	-
Tunisia	1	-	lacking	unknown	-
Turkey	1	-	committed	unknown	-
Turkmenistan	1	-	committed	1995	-
Ukraine	1	1	committed	1995/1996	yes/no
United Kingdom	0	3	committed	1994/1996	yes/yes
United States	7	11	committed	1994	yes/yes
Venezuela	0	1	committed	1995	-
Western Samoa	0	1	committed	1994	-
Zambia	0	1	committed	1995	-
TOTAL (Committed)	**60(55)**	**119 (116)**			**34/23**

1. Envisaged GSETT-3 Primary station currently used as a GSETT-3 auxiliary station.

Table 2: GSETT-3 Stations

Station Name (in alphabetical order)	Code	Type	Station Type	Latitude	Longitude	Data used by IDC by 24 May 1996	In envisaged IMS network
Argentina							
Paso Flores	PLCA	α	3-C	-40.731	-70.550	yes	yes
Coronel Fontana	CFA	β	3-C	-31.607	-68.239	no	yes
Ushuaia	USHA	β	3-C	-54.800	-68.300	no	yes
Armenia							
Garni	GNI	β	3-C	40.050	44.720	no	yes
Australia							
Alice Springs	ASAR	α	array	-23.666	133.904	yes	yes
Mawson, Antarctica	MAW	α	3-C	-67.604	62.871	yes	yes
Stephens Creek	STKA	α	3-C	-31.882	141.592	yes	yes
Warramunga	WRA	α	array	-19.943	134.339	yes	yes
Woolibar	WOOL	α	3-C	-31.073	121.678	yes	no
Armidale	ARMA	β	3-C	-30.420	151.628	yes	no
Casey	CSY	β	1-C	-66.289	110.529	yes	no
Charters Towers	CTA	β	3-C	-20.088	146.254	yes	yes
Fitzroy Crossing	FITZ	β	3-C	-18.103	125.643	yes	yes
Forrest	FORT	β	1-C	-30.779	128.059	yes	no
Meekatharra	MEEK	β	1-C	-26.614	118.536	yes	no
Mount Isa	QIS	β	1-C	-20.558	139.605	yes	no
Narrogin	NWAO	β	3-C	-32.927	117.233	yes	yes
Roma	RMQ	β	1-C	-26.489	148.755	yes	no
Toolangi	TOO	β	3-C	-37.571	145.491	yes	no
Warburtan	WARB	β	3-C	-26.184	126.643	yes	no
Young	YOU	β	1-C	-34.278	148.382	yes	no
Austria							
Molln	MOA	β	3-C	47.850	14.266	no	no
Bolivia							
La Paz	LPAZ	α	3-C	-16.288	-68.131	yes	yes
Botswana							
Lobatse	LBTB	α	3-C	-25.015	25.597	no	yes, as auxiliary
Brazil							
Brasilia	BDFB	α	3-C	-15.642	-48.015	yes	yes
Pitinga	PTGA	β	3-C	-3.060	-60.000	yes	yes
Rio Grande do Norte	RGNB	β	3-C	-6.910	-36.950	no	yes
Bulgaria							
Vitosha	VTS	β	3-C	42.618	23.238	no	no
Canada							
Lac du Bonnet	ULM	α	3-C	50.250	-95.875	yes	yes
Mould Bay	MBC	α	3-C	76.242	-119.360	yes	yes, as auxiliary
Schefferville	SCH	α	3-C	54.817	-66.783	yes	yes
Waterton Lakes	WALA	α	3-C	49.059	-113.912	yes	no

Station Name (in alphabetical order)	Code	Type	Station Type	Latitude	Longitude	Data used by IDC by 24 May 1996	In envisaged IMS network
Whitehorse	WHY	α	3-C	60.660	-134.881	yes	no
Yellowknife	YKA	α	array	62.493	-114.605	yes	yes
Bella Bella	BBB	β	3-C	52.185	-128.113	yes	yes
Caledonia Mtn.	LMN	β	3-C	45.852	-64.806	yes	no
Dawson City	DAWY	β	3-C	64.066	-139.391	yes	no
Dease Lake	DLBC	β	3-C	58.417	-130.060	yes	yes
Deer Lake	DRLN	β	3-C	49.256	-57.504	yes	no
Edmonton	EDM	β	3-C	53.222	-113.350	yes	no
Eldee	EEO	β	1-C	46.641	-79.073	yes	no
Fort Churchill	FCC	β	3-C	58.761	-94.087	yes	no
Glen Almond	GAC	β	3-C	45.703	-75.478	yes	no
Inuvik	INK	β	3-C	68.307	-133.520	yes	yes
Iqaluit	FRB	β	3-C	63.747	-68.547	yes	yes
La Malbaie	LMQ	β	3-C	47.548	-70.327	yes	no
Pac. Geoscience	PGC	β	3-C	48.650	-123.451	yes	no
Pemberton	PMB	β	3-C	50.520	-123.073	yes	no
Penticton	PNT	β	3-C	49.317	-119.617	yes	no
Resolute Bay	RES	β	3-C	74.687	-94.900	yes	no
Sadowa	SADO	β	3-C	44.769	-79.142	yes	yes
Thunder Bay	TBO	β	1-C	48.647	-89.408	yes	no
Central African Republic							
Bangui	BGCA	α	3-C	5.176	18.424	yes	yes
Chile							
Rapa Nui	RPN	β	3-C	-27.160	-109.430	yes	yes
China, Peoples Republic of							
Beijing	BJT	α	3-C	40.018	116.168	yes	yes, as auxiliary
Hailar	HIA	α	3-C	49.267	119.742	yes	yes
Lanzhou	LZH	α	3-C	36.087	103.844	no	yes
Colombia							
El Rosal	ROSC	α	3-C	4.860	-74.330	no	yes
Cook Islands							
Rarotonga	RAR	β	3-C	-21.213	-159.773	yes	yes
Costa Rica							
Las Juntas de Abangares	JTS	β	3-C	10.290	-84.950	yes	yes
Czech Republic							
Vranov	VRAC	β	3-C	49.311	16.596	yes	yes
Denmark							
Søndre Strømfjord	SFJ	β	3-C	67.050	-50.300	no	yes
Egypt							
LUXESS	LXAR	α	array	26.000	33.00 0	no	yes
Ethiopia							
Addis Ababa	AAE	β	3-C	9.029	38.766	yes	yes

Station Name (in alphabetical order)	Code	Type	Station Type	Latitude	Longitude	Data used by IDC by 24 May 1996	In envisaged IMS network
Fiji							
Monasavu	MSVF	β	3-C	-17.750	178.050	no	yes
Finland							
FINESS	FINES	α	array	61.444	26.077	yes	yes
Kangasniemi	KAF	β	3-C	62.113	26.306	yes	no
Ylistaro	VAF	β	3-C	63.042	22.672	yes	no
France							
Lormes	LOR	α	3-C	47.268	3.859	yes	no
Germany							
GERESS	GERES	α	array	48.845	13.702	yes	yes
Berggiesshübel	BRG	β	3-C	50.875	13.947	yes	no
Black Forest	BFO	β	3-C	48.331	8.330	yes	no
Bochum	BUG	β	3-C	51.446	7.264	yes	no
Clausthal-Zellerfeld	CLZ	β	3-C	51.843	10.374	yes	no
Collm	CLL	β	3-C	51.310	13.000	yes	no
Fürstenfeldbruck	FUR	β	3-C	48.164	11.277	yes	no
Gräfenberg	GRFO	β	3-C	49.692	11.205	yes	no
Moxa	MOX	β	3-C	50.646	11.616	yes	no
Taunus	TNS	β	3-C	50.224	8.449	yes	no
Hungary							
Piszkes	PSZ	β	3-C	47.918	19.895	yes	no
Iceland							
Borgarnes	BORG	β	3-C	64.750	-21.330	yes	yes
India							
Gauribidanur	GBA	α	array	13.604	77.436	no	yes
Indonesia							
Jakarta	PACI	α	3-C	-6.593	106.910	no	yes, as auxiliary
Iran, Islamic Republic of							
Tehran	THR	α	3-C	35.818	51.393	no	yes
Kerman	KRM	β	3-C	30.280	57.070	no	yes
Masjed-e-Solayman	MSN	β	3-C	31.930	49.300	no	yes
Israel							
Bar Giyora	BGIO	β	3-C	31.722	35.092	yes	no
Parod	PARD	β	array	32.550	35.260	no	yes
Atar Shivta	ATR	β	3-C	30.970	34.630	no	no
Eilath	MBH	β	3-C	29.790	34.910	no	yes
Italy							
L'Aquila	AQU	β	3-C	42.354	13.405	yes	no
Villasalto	VSL	β	3-C	39.496	9.378	yes	no
Ivory Coast							
Dimbroko	DBIC	α	3-C	6.670	-4.856	yes	yes
Japan							
Matsushiro	MJAR	α	array	36.543	138.207	yes	yes

Station Name (in alphabetical order)	Code	Type	Station Type	Latitude	Longitude	Data used by IDC by 24 May 1996	In envisaged IMS network
Aobayama	AOB	β	3-C	38.250	140.850	no	no
Chichijima	OGS	β	3-C	27.060	142.200	yes	yes
Hachijojima	HCH	β	3-C	33.120	139.800	no	yes
Ishigakijima	ISG	β	3-C	24.380	124.230	yes	no
Kaminokuni	KKJ	β	3-C	41.780	140.180	yes	no
Shiraki	SHK	β	3-C	34.530	132.680	yes	no
Tsukuba	TSK	β	3-C	36.210	140.101	yes	no
Kazakhstan							
Aktubinsk	AKT0	α	3-C	50.434	58.018	no	yes
Borovoye	BRVK	β	array	53.058	70.283	no	yes
Kurchatov	KURK	β	array	50.715	78.621	no	yes
Makanchi	MAK	β	3-C	46.808	81.977	no	yes
Kenya							
Kilima Mbogo	KMBO	α	3-C	-1.127	37.252	no	yes
Korea, Republic of							
Wonju	KSRS	α	array	37.450	127.920	no [1]	yes
Mexico							
To be defined	XMEX	α	3-C	18.000	-96.000	no	no
Chilapa	CHAM	β	3-C	17.000	-99.000	no	no
Iguala	IGUM	β	3-C	19.000	-100.000	no	no
Mongolia							
Javkhlant	ALFM	α	3-C	47.991	106.766	no	yes
Ulaan-Baatar	ULN	β	3-C	47.520	107.030	yes	no
Namibia							
Tsumeb	TSUM	β	3-C	-19.202	17.584	yes	yes
Netherlands							
Heimansgroeve	HGN	β	3-C	50.764	5.932	yes	no
New Zealand							
South Karori	SNZO	β	3-C	-41.310	174.705	yes	no
Norway							
ARCESS	ARCES	α	array	69.535	25.506	yes	yes
NORSAR	NAO	α	array	60.824	10.832	no	yes
Spitsbergen	SPITS	α	array	78.178	16.370	yes	yes, as auxiliary
NORESS	NORES		array	60.735	11.541	yes, as a substitute for NAO	no
Jan Mayen Island	JMI	β	3-C	70.920	-8.720	no	yes
Pakistan							
Pari	PKAR	α	array	33.050	73.252	no	yes
Nilore	NIL	β	3-C	33.650	73.250	yes	no
Papua New Guinea							
Port Moresby	PMG	α	3-C	-9.409	147.154	yes, as β station	yes, as auxiliary

1. Data currently received at the IDC, but not yet used in processing.

Station Name (in alphabetical order)	Code	Type	Station Type	Latitude	Longitude	Data used by IDC by 24 May 1996	In envisaged IMS network
Paraguay							
Villa Florida	CPUP	α	3-C	-26.331	-57.329	yes	yes
Peru							
Nana	NNA	β	3-C	-11.990	-76.840	no	yes
Philippines							
Davao	DAV	β	3-C	7.090	125.570	yes	yes
Poland							
Suwalki	SUW	β	3-C	54.001	23.182	no	no
Portugal							
To be defined		β	3-C			no	no
Romania							
Muntele Rosu	MLR	β	3-C	45.492	25.944	no	yes
Russian Federation							
Khabaz	KBZ	α	3-C	43.729	42.898	yes	yes
Norilsk	NRI	α	3-C	69.400	88.100	yes	yes
Peleduy	PDY	α	3-C	59.633	112.700	yes	yes
Ussuriisk	USK	α	3-C	44.283	132.083	no	yes
Zalesovo	ZAL	α	3-C	53.940	84.805	yes	yes
Arti	ARU	β	3-C	56.430	58.563	yes	yes
Kislovodsk	KIV0	β	array	43.956	42.695	yes	yes
Obninsk	OBN	β	3-C	55.117	36.600	yes	yes
Urgal	URG	β	3-C	51.099	132.364	no	yes
Zilim	UFA	β	3-C	53.850	57.050	no	yes
Seychelles							
Mahe	MSEY	β	3-C	-4.61	55.49	yes	no
Solomon Islands							
Honiara	HNR	β	3-C	-9.432	159.47	yes	yes
South Africa							
Boshof	BOSA	α	3-C	-28.614	25.556	yes	yes
Silverton	SLR	β	3-C	-25.740	28.280	no	no
Sutherland	SUR	β	3-C	-32.380	20.810	yes	yes
Spain							
Sonseca	ESDC	α	array	39.677	-3.962	yes	yes
San Pablo de los Montes	PAB	β	3-C	39.546	-4.348	yes	no
Taburiente	TBT	β	3-C	28.679	-17.913	yes	no
Sweden							
Hagfors	HFS	α	array	60.134	13.697	yes	yes, as auxiliary
Switzerland							
Alpnach	APL	β	3-C	46.950	8.243	yes	no
Davos	DAVOS	β	3-C	46.840	9.790	yes	yes
Thailand							
Chiang Mai	CMAR	α	array	18.458	98.943	yes	yes

Station Name (in alphabetical order)	Code	Type	Station Type	Latitude	Longitude	Data used by IDC by 24 May 1996	In envisaged IMS network
Tunisia							
Thala	THA	α	3-C	35.560	8.700	no	yes
Turkey							
Belbashi	BRTR	α	array	39.870	32.790	no	yes
Turkmenistan							
Alibek	ABKT	α	array	37.930	58.199	yes	yes
Ukraine							
Malin	AKASG	α	array	50.600	29.400	no	yes
Kiev	KIEV	β	3-C	50.694	29.208	yes	no
United Kingdom							
Eskdalemuir	EKA	β	array	55.333	-3.159	yes	yes, as auxiliary
Wolverton	WOL	β	3-C	51.313	-1.223	yes	no
Ascension Island	ASCN	β	3-C	-7.950	-14.380	yes	no
United States							
Lajitas	TXAR	α	array	29.334	-103.667	yes	yes
Lisbon	LBNH	α	3-C	44.240	-71.926	yes	no
Mount Ida	MIAR	α	3-C	34.546	-93.573	yes	no
North Pole	NPO	α	3-C	64.771	-146.887	yes	Nearby station ELAK in IMS
Pinedale	PDAR	α	array	42.767	-109.558	yes	yes
Pinon Flats	PFO	α	3-C	33.609	-116.455	yes	yes
Vanda, Antarctica	VNDA	α	3-C	-77.514	161.846	yes	yes
Albuquerque	ALQ	β	3-C	34.946	-106.457	yes	yes
Black Hills	RSSD	β	3-C	44.120	-104.036	yes	no
Blacksburg	BLA	β	3-C	37.211	-80.421	yes	no
Dugway	DUG	β	3-C	40.195	-112.816	yes	no
Elko	ELK	β	3-C	40.745	-115.239	yes	yes
Ely	EYMN	β	3-C	47.947	-91.508	yes	no
Mina	MNV	β	3-C	38.433	-118.153	yes	no
Newport	NEW	β	3-C	48.263	-117.120	yes	yes
Tucson	TUC	β	3-C	32.310	-110.785	yes	no
Tuckaleechee Caverns	TKL	β	3-C	35.658	-83.774	yes	yes
Tulsa	TUL	β	3-C	35.911	-95.793	yes	no
Venezuela							
Santo Domingo	SDV	β	3-C	8.879	-70.633	yes	yes
Western Samoa							
Afiamalu	AFI	β	3-C	-13.909	-171.779	yes	yes
Zambia							
Lusaka	LSZ	β	3-C	-15.277	28.188	yes	yes

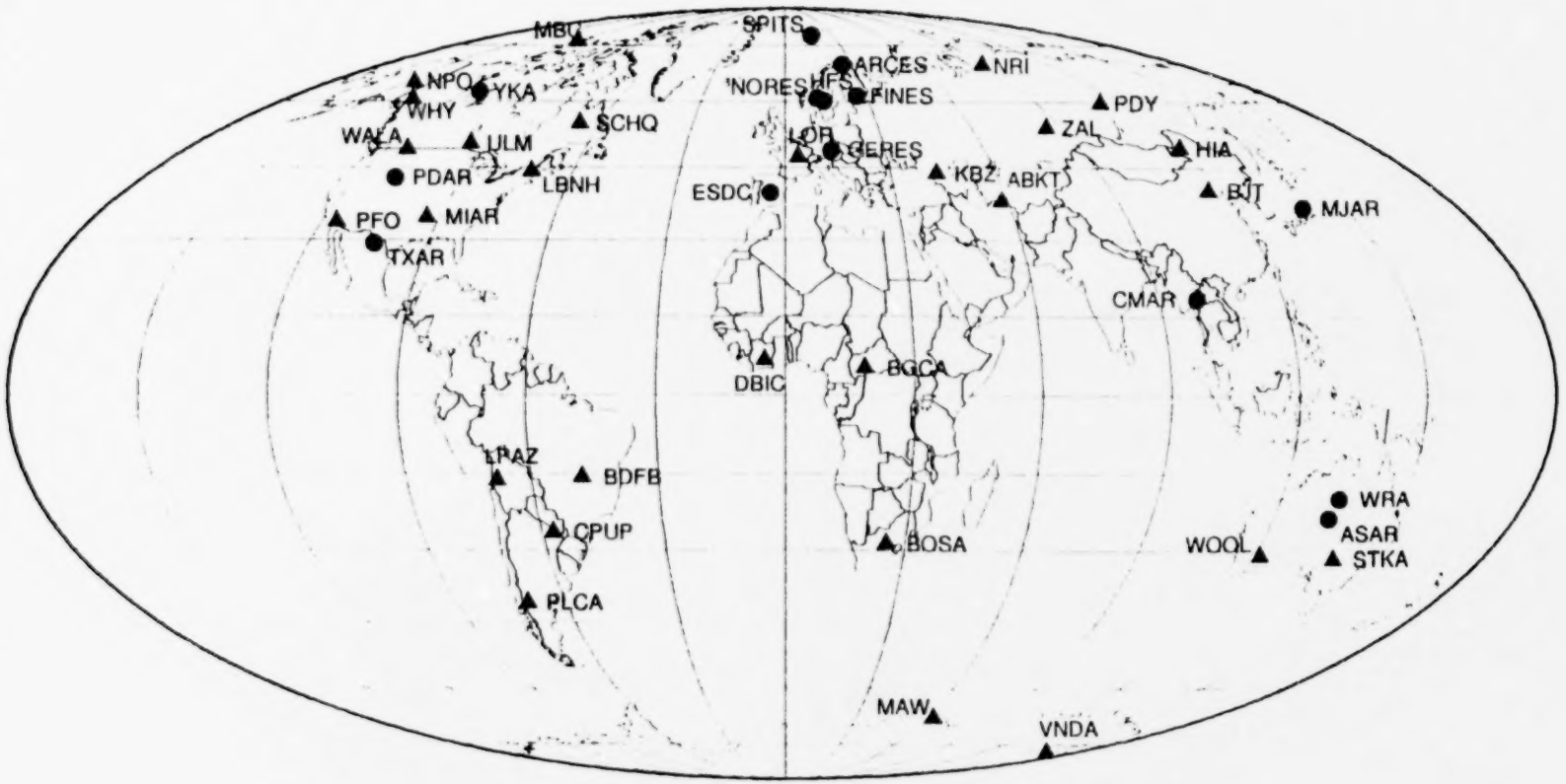

Fig. 1. GSETT-3 primary (Alpha) stations used by the IDC as of 24 May 1996. Arrays are shown as filled circles and three-component stations as filled triangles.

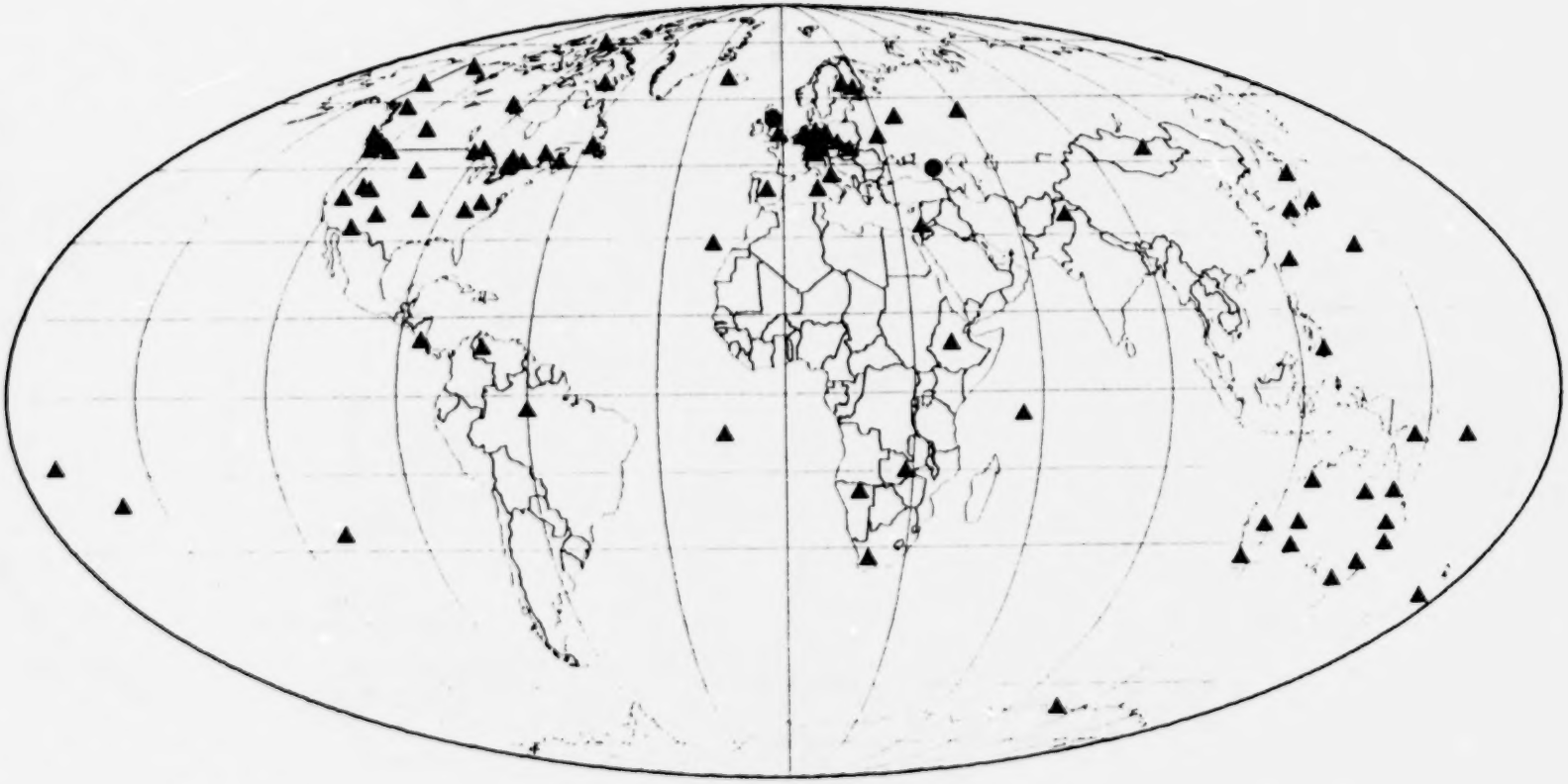

Fig. 2. GSETT-3 auxiliary (Beta) stations that have been used by the IDC by 24 May 1996. Arrays are shown as filled circles and three- and one-component stations as filled triangles.

ANNEX 2

INITIAL PLAN FOR IMPROVING EVENT LOCATION THROUGH CALIBRATION

As GSETT-3 has progressed, comparisons by National Data Centres and by the Working Group on Evaluation (WGE) have noted significant differences between locations reported in the Reviewed Event Bulletins (REBs) and those independently determined by other agencies and by networks which are much denser than those used in producing the REBs. The GSE has noted a need for calibration of travel-time information in order to improve REB locations. At the International Data Center (IDC), some development has been carried out towards implementing such calibration. This development has involved not only the regular staff of the IDC, but also visiting international staff and academic and governmental research institutions in a number of countries.

Based on discussions during its 44th session, the GSE came up with a plan for short term (next 3 months) and long-term developments that would further the improvement of event location through calibration. This effort would focus upon the larger (Mb 3.5 and greater) events, recorded to teleseismic distances, that make up the bulk of the REB. The goal is to achieve a location accuracy of 1000 sq. km or better (less than 17 km difference between "ground truth" and IDC locations) for events of magnitude 4 and greater, although it is noted that this may not be possible in some parts of the world, notably in some oceanic areas with poor station coverage.

Empirical and model corrections to be applied in the location process will be evaluated using a standard procedure which involves comparisons with ground truth locations, and locations of other well-recorded and well-located events. Adoption of new empirical or model based corrections in an operational mode will be based on the results of this evaluation.

SHORT TERM: Generate, test and apply teleseismic station corrections; collect ground truth data: propose and test global regionalization of travel-time curves; experiment with interpolation methods for path corrections and establish scale length of path-dependent corrections.

A. Station Corrections

- Select a set of past larger (m4-5) well-recorded (e.g. Nsta > 30, < 90) events and, using teleseismic data only, iteratively establish station corrections.

- To establish stability of the method, repeat the above with an independent set of events and confirm that the same corrections are obtained.

- Apply these corrections and, for those events with ground truth (see below), verify that the revised locations are an improvement.

- Implement resulting corrections to produce a parallel bulletin for a test period.

- Submit a proposal for the implementation of station corrections to the Configuration Control Board.

B. Calibration Events

- Select one "calibration" event each day, on average, with the aim being to produce a global distribution of such events. Such events are to be of mb 4.0 - 5.5. The selection of such events is to start on June 1, 1996.

- Request all auxiliary (beta) data from stations in the future IMS for such events, and apply special care in the waveform analysis of such events.

- Supplement these events with ones from the earlier part of GSETT-3 which, by virtue of their unique location or quality of available ground truth information, are of special use. NDCs are encouraged to propose such events.

- Publish (Web page and with GSETT-3 Updates) a list of these events, requesting additional data from NDCs within whose network coverage region they lie, or for which such data are available from other techniques. This additional data provided by NDCs should include local phase readings so that location quality, especially depth, can be assessed, and digital waveform data would also be helpful.

- Establish quality assurance procedures to ensure that only events with the best possible locations are included in the list of calibration events.

- NDCs should also provide information on large explosions with known origins (real ground truth data).

- Encourage conduct of specific chemical calibration explosions in various regions.

- Make waveform data for all these types of calibration events readily available on-line at the IDC for both internal and external use. Such data would include hydroacoustic and infrasonic data, in addition to seismic data.

- Contemplate using data from existing stations in aseismic areas for events located close to IMS stations, thereby obtaining otherwise unavailable calibration information through reciprocity considerations.

C. Regionalization

An effort separate from those of items A and B above is the development of regionalized travel time-models:

- A proposed regionalization and corresponding travel-time curves were presented to the GSE in GSE/WGP/12 for comment and revision as necessary.

- Verify these proposed regional travel-time curves using ground truth events where available, and well-determined teleseismic (only) locations elsewhere.

D. Interpolation and Scale Length of Corrections

- In selected source regions for which ground truth solutions are available, determine path (station-source) corrections and experiment to establish scale length over which corrections apply. Test different interpolation techniques.

E. Updating Corrections

- Define and apply methods for periodically updating travel time corrections as new stations are added and useful events occur in previously uncovered regions of the world.

LONGER TERM: Acquire a better statistical understanding of the IDC location processing; review event definition criteria; complete development, specification and evaluation of 1-D models; complete development and evaluation of 3-D modelling approach.

F. Statistics

- Re-assess a priori standard deviations used in IDC processing, particularly for regional phases, to include systematic biases.

- Establish statistical framework for applying datum dependent variances to reduce station, signal-to-noise, and distance dependent biases.

- Implement datum dependent variances and validate against reference events, particularly for combining teleseismic and regional observations.

- Re-evaluate confidence ellipse assumptions in the light of NDC reports that 90% coverage ellipses contain barely more than half of all NDC locations.

G. Event Definition Criteria

- Experiment with different event definition criteria and propose changes as appropriate.

- Investigate possible use of hydroacoustic data in combination with seismic data for event definition.

H. 1-D and 3-D Modelling

- Once the regionalization (see C above) and corresponding travel time curves have been approved and validated, apply 1-D (station/phase dependent) travel time curves.

- Develop, test and verify a 3-D modelling approach to derive baseline smoothed travel times at all distance for all phases and depths.

Annex 3

GSE WORKSHOPS IN SOUTH AMERICA AND AFRICA

The GSE held regional Workshops in San Juan, Argentina for the Central and South American region from 20 to 22 November 1995, and in Pretoria, South Africa for the African region from 22 to 24 April 1996. The purpose of these Workshops was to increase awareness of the GSETT-3 experiment and the future International Monitoring System of the CTBT, and to encourage the participation of countries in these regions of the southern hemisphere. The Workshops were well attended by seismologists and government representatives from many countries in the regions of Central and South America and Africa. A third Workshop is being planned for the Southeast Asian region in September 1996.

The Workshops were opened by officials of the respective Ministry of Foreign Affairs, followed by a presentation by the CD Secretariat on the CTBT negotiations in the Conference on Disarmament. Members of GSE made presentations on the role and need for technical expertise in the negotiations, technologies for CTBT verification, GSE and the GSETT-3, aspects of planning and documentation of GSETT-3, the role and functions of the National Data Centres and the International Data Centre, evaluation of GSETT-3 and the need for incorporating region-specific knowledge, and what GSETT-3 participation implies. In addition, representatives of various countries spoke about their bilateral co-operative efforts to assist other countries in participating in GSETT-3.

Following these presentations, a diplomat and/or seismologist from each participating country spoke about their country's interest in disarmament and the CTBT, the seismicity of their region or territory, the number and type of seismic stations in their country, the personnel operating them, the type of communications facilities they possessed for transmitting the data, including whether or not they had access to Internet, co-operative agreements with other countries or organizations, and their plans for participating in GSETT-3 and the future IMS, including potential problems envisaged therewith.

The last day was devoted to an exchange between GSE members and participants from countries of the respective region. Specific topics covered included: formal aspects of participation in GSE and GSETT-3; how to have more countries from the region actively involved in the work of the GSE and in the efforts towards establishing the treaty monitoring system,

including participation with seismic stations in GSETT-3; provision of local bulletins and reference data, and access to the IDC bulletins and reference data; evaluation of the system; training of seismic analysts at the International Data Centre; the contribution to be made by GSETT-3 and the countries of each region in providing region-specific knowledge which is essential for the calibration of the network; non-seismic technologies (a number of the participating countries are also on the lists in the rolling text of the CTBT for radionuclide, infrasound, and hydroacoustic monitoring technologies); and funding, as many of these countries need financial assistance in this endeavour.

There was a mutually beneficial exchange of information and ideas among Workshop participants, who seemed anxious to find ways to participate in the system. They recognized that it will be essential for the monitoring of a CTBT as well as extremely beneficial in terms of the scientific exchange of information regarding e.g. earthquake hazards. The widespread willingness to participate in GSETT-3 was encouraging and the provision of additional gamma data and region-specific information will enable improvement of the performance, through calibration, of the GSETT-3 network in the regions of Central and South America and Africa. Participants agreed to establish a dialogue on the above-mentioned items. GSE is sending sample GSETT-3 bulletins, Progress Reports of the GSE, and evaluation data to participants, will assist them in establishing regional bulletins, and will solicit data and information from these countries.

The Workshops in South America and Africa have been extremely valuable for participation not only in the GSETT-3, but in the future IMS as well. A direct exchange in the respective regions among GSE members, scientists and representatives of Governments which will be responsible for the stations monitoring the future treaty has proven mutually beneficial in this regard. The GSE would like to express its appreciation to the Governments of Argentina and South Africa for hosting these Workshops and to the other countries which contributed financially to making them possible.